$$\frac{d^2f}{dt^2} = \frac{1}{\mu K}\nabla^2 f + \frac{1}{4\pi\mu}\left(p_1\frac{d}{dx}+p_2\frac{d}{dy}+p_3\frac{d}{dz}\right)\left(\frac{d\dot{g}}{dz}-\frac{d\dot{h}}{dy}\right) \dots \quad (2).$$

The boundary conditions are : continuity of magnetic induction and electric displacement perpendicular to the reflecting surface, the latter of which is equivalent to continuity of magnetic force perpendicular to the plane of incidence; continuity of magnetic force along the line of intersection of the plane of incidence with the reflecting surface; continuity of the rate at which energy flows across the reflecting surface. Now the refracted light consists of two waves, circularly polarised in opposite directions, and the reflected light is elliptically polarised; we have, therefore, four equations to determine the amplitudes of the two refracted waves, and the amplitudes of the two components of the reflected wave.

The results of the paper agree with Dr. Kerr's experiments in the following particulars :—

(i.) The reflected light is elliptically polarised.

(ii.) When the magnetisation is parallel to the reflecting surface, no effect is produced when the incidence is normal, or when the plane of incidence is perpendicular to the direction of magnetisation.

(iii.) When the plane of incidence is parallel to the direction of magnetisation, and the light is polarised *in* the plane of incidence, the magnetic term increases from grazing incidence to a maximum value, and then decreases to normal incidence.

The principal point of disagreement is, that in all cases the intensity of the reflected light is unchanged when the direction of the magnetising current is reversed.

I do not think that the results of the theory can be considered altogether unsatisfactory, since they certainly explain some of Dr. Kerr's experimental results; and I am disposed to think that the disagreement is due to the disturbing influence of metallic reflection. At the same time, the question is one which can only be decided by experiment, and it is therefore most desirable that experiments on magnetised solutions should be made.

IV. "Further Contributions to the Metallurgy of Bismuth." By EDWARD MATTHEY, F.S.A., F.C.S., Assoc. Roy. Sch. Mines. Communicated by Sir G. G. STOKES, Bart., F.R.S.

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In October, 1887, I read a paper before the Royal Society* upon a new method which I incidentally discovered while working with a view to separate copper from bismuth, by fusion with bismuth sulphide.

* 'Roy. Soc. Proc.,' vol. 43, p. 172.

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I stated in this paper that bismuth "frequently contains a small proportion of copper, an element most detrimental even in small traces, and hitherto only eliminated by a wet process, costly in practice and tedious in operation. It is necessary by such method to dissolve up the whole of the alloy, and precipitate the bismuth in the usual manner—a bulky operation, and one requiring a considerable amount of time. It became therefore advisable, in order to treat cupriferous bismuth rapidly and upon a commercial scale, to effect this separation, if possible, by means of a dry process."

In further researches in the metallurgy of this interesting metal, a case was found in which bismuth contained a very small proportion of copper, under 0·5 per cent., but sufficient to render the metal useless, and in fact, to destroy those characteristic properties upon which its industrial applications depend.

Instead of treating this cupriferous bismuth by fusion with bismuth sulphide, which necessitates a temperature sufficiently elevated to bring about a complete fusion of the bismuth sulphide, and consequently, unless very great care be taken, great loss by volatilisation of bismuth, it occurred to me to fuse the alloy, and, at a temperature a little above its melting point, to add a small proportion of sodium monosulphide. The mass was then stirred well, so as to bring every portion of the fused alloy into contact with the fused sulphide.

After about one hour's stirring, a test was made of the molten metal, and it was found that the amount of copper in it was very considerably decreased.

By skimming off the film of scoria which had risen to the surface, adding a further small proportion of the sodium monosulphide, and continuing the operation of stirring, every trace of copper was eliminated, and the bismuth so freed from copper rendered in every way suitable for industrial use.

The first experiment was made upon a quantity of 105 kilograms, which yielded 94 kilograms of bismuth free from copper, and about 11 kilograms of skimmings containing the whole of the copper, their bismuth contents of course being available for reduction with further and larger quantities of skimmings as they accumulated.

This process has been repeated upon very considerable quantities of cupriferous bismuth, and has proved to be successful.

This question of keeping the temperature low is of much importance, for the lower the temperature the less tendency there is for the bismuth to volatilise, and as it is necessary to obtain the bismuth free from traces of impurity, which entirely change its nature, it will be seen that any improvement in manipulation, or in the process itself, which enables pure metal to be obtained possesses much interest.